



CALIFORNIA
ENERGY
COMMISSION

Semi-Annual Report Concerning The Public Interest Energy Research Program

November 1, 2001 through April 30, 2002

Report to
the Governor and Legislature

COMMITTEE REPORT

May 2002
P500-01-012v6



Gray Davis, Governor

May 31, 2002

Members of the Senate Energy, Utilities and Communications Committee
Members of the Senate Budget and Fiscal Review Committee
Members of the Senate Appropriations Committee
Members of the Assembly Utilities and Commerce Committee
Members of the Assembly Budget Committee
Members of the Assembly Appropriations Committee
California State Capitol Building
Sacramento, California 95814

**The California Energy Commission's Semi-Annual Report Concerning
The Public Interest Energy Research Program**

Dear Members:

In accordance with Public Resources Code Section 25620.5(h), the California Energy Commission hereby transmits its Semi-Annual Report regarding the Public Interest Energy Research (PIER) Program for the period November 1, 2001 through April 30, 2002. (The Legislative Analyst has requested that all PIER Program semi-annual reports be submitted on or before June 1 and December 1 of each year.) The enclosed report provides the required evaluation of the progress and a status of the PIER Program's implementation for this reporting period.

The Energy Commission is continuing to make substantial progress in meeting the goals of the PIER Program, as demonstrated by the results of PIER-funded projects that will advance science and technology to improve the quality of life for California citizens. Should you have questions or comments concerning this report, please feel free to contact Tim Schmelzer, Assistant Director in the Energy Commission's Office of Governmental Affairs, at 654-4942.

Respectfully submitted,

ARTHUR H. ROSENFELD

Commissioner and Presiding Member
Research, Development and
Demonstration Committee

ROBERT A. LAURIE

Commissioner and Associate Member
Research, Development and
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Enclosure

cc: Legislative Analyst's Office

California Energy Commissions Semi-Annual Report Concerning the Public Interest Energy Research Program (November 1, 2001 through April 30, 2002)

In accordance with Public Resources Code (PRC) Section 25620.5(h), this document constitutes the California Energy Commission's *Semi-Annual Report* for the Public Interest Energy Research (PIER) Program, covering the period from November 1, 2001, through April 30, 2002. (The Legislative Analyst has requested that all PIER Program semi-annual reports be submitted on or before June 1 and December 1 of each year.)

This report provides the required "evaluation of the progress and a status of the PIER Program's implementation" for this six-month period. It also provides input for the Energy Commission's more detailed *Annual Report Concerning the Public Interest Energy Research Program* (hereafter referred to as *Annual PIER Report*) required pursuant to PRC Section 25620.8.

I. SUMMARY STATUS OF THE PIER PROGRAM

During this reporting period, the PIER Program accomplished the following:

- Work in the **Renewable Energy** program area focused on three major activities during this reporting period. The first set of work involved management and integration of the large number of ongoing projects in this area. In 2001, over \$35 million in PIER awards were made for renewable energy research, bringing the total level of PIER funding in this area to over \$52 million. The second set of work involved developing a California biomass energy consortium and releasing a targeted solicitation on advanced biogas to electricity systems. Over \$5.4 million in PIER funding was allocated for these activities. The third set of work focused on developing and managing the Energy Commission's \$10 million California Dairy Power Production Program.
- The **Environmentally Preferred Advanced Generation** (EPAG) program area released a \$6 million solicitation for Advanced Reciprocating Internal Combustion Engine (ARICE) projects. Twelve proposals were received and 3 of those proposals received passing scores. A Notice of Proposed Awards (NOPA) will be released in May 2002, after the reporting period of this document.
- The **Buildings End-Use Energy Efficiency** program area was notified of a successful award on one of two proposals submitted to the federal Department of Energy (DOE) for multi-state collaborative research. A contract to initiate this *Capturing the Daylight Dividend* collaboration will be developed later this year.

In addition, several new energy efficiency research contracts were initiated including the following: a collaboration with other government agencies to develop advanced windows with electrochromic glazings; development of cool colored roofing materials; and testing of duct sealant products to assess performance, in support of Title 24 Standards compliance.

- The **Industrial/Agricultural/ Water Energy Efficiency** program initiated projects to lower electric consumption and increase reliability with several entities, including the food processing industry, the Emerging Technology Coordination Council, the electronics and e-commerce industries, and the Lawrence Berkeley National Laboratory. In collaboration with the Electric Power Research Institute (EPRI) this PIER program area has completed two analytical studies dealing with the issue of power quality and its impact on California industries. The program area also continued its on-going work with the food processing, electronics and water treatment industry to develop RD&D roadmaps based on issues and concerns specific to these industries.
- The **Energy-Related Environmental Research** program area is finalizing its research roadmaps in the areas of Water Impacts, Land Use Impacts, Air Quality Impacts and Global Climate Change. The next milestone for roadmap development is workshops where staff will present the identified research issues and interact with recognized experts in order to incorporate suggestions and correct any deficiencies. Many projects addressing these research focus areas are now under way and some of them are completed. One, the California Greenhouse Gas Inventory, represented a considerable investment of staff time and effort and resulted in a useful tool for California's policy-makers.
- The **Energy Systems Integration (ESI) Research** program is continuing research in two major areas: the Consortium for Electric Reliability Technology Solutions (CERTS), to address the transition of California's electricity supply and delivery infrastructures from vertically integrated, regulated and government-controlled organizations to desegregated, competitive market-driven institution; and the Pacific Earthquake Engineering Research Center (PEER), to develop technologies and protocols to mitigate the vulnerability of electric systems to damage caused by earthquakes. ESI also initiated funding with the Electric Power Research Institute to conduct a public workshop on recent research looking at alternative competitive market structures for California. ESI is also seeing results from research efforts with ADL for a Strategic Distributed Energy Resources Research Assessment to provide current, reliable, and actionable information to assist policy makers, consumers, researchers, academic community and other interested parties in evaluating and implementing distributed energy resources.

II. PIER PROGRAM AREA FUNDING STATUS

A. Renewable Energy Technologies

Management and Integration Activities:

A significant focus during this reporting period involved management and integration of the large number of projects on-going during 2001. In particular, the portfolio of projects increased dramatically from fewer than 40 projects representing \$17 million of PIER funds to over 110 projects representing \$53 million in PIER funds. Activities included:

- Initiation of programmatic contracts with the Sacramento Municipal Utilities District (\$13.6 million) and with Commonwealth Energy Corporation (\$11.7 million). A programmatic contract with the Northern California Power Agency as the managing prime contractor (\$5.9 million) was not accepted by NCPA. However, the collection of projects will be conducted for the same scope of work and budget under a contract with Hetch Hetchy Water and Power.
- Initiation and integration of a number of California-focused activities to help improve the use of wind energy in meeting California's electricity needs and expand wind energy in California. The integrated activities include:
 - California Wind Energy Consortium
 - California Wind Atlas
 - California Wind Forecasting Tool
 - California Wind Technology Development Activities
- Completion of eight projects started in earlier budget years. Projects completed during this reporting period include:
 - EdTek: Hybrid Thermophotovoltaic Power Systems
 - WTC: Next Generation Wind Turbine (Prototype)
 - GTI: Gas Cofiring in Biomass Boilers
 - CPC: Small Modular BioPower System
 - PowerLight: PowerGuard Manufacturing Improvements
 - PowerLight: PowerTherm
 - EMI: GeoBilt Geothermal Logging Tool
 - Berquam: Solar Absorption Chiller

New Renewable R&D Activities:

Over \$5.4 million in PIER funds was allocated to new renewable R&D activities during this reporting period. \$5 million in funding was directed to a targeted solicitation on accelerating development of advanced biogas-to-electricity

technologies. In addition, the Commission approved a \$415,716 contract for the development of a California biomass energy consortium.

California has over 310 active landfills, 170 transfer stations, 240 wastewater treatment facilities, and over 2000 livestock operations that generate 1.5 million tons per year of methane emissions. Capturing and converting the methane released from these facilities can provide Californians with up to 240 megawatts of renewable electricity generation capacity and cleaner air. The purpose of the targeted biogas solicitation is to accelerate development of biogas technologies that can help meet peak electricity demands, increase system reliability at a local level, provide enhanced affordability of electricity and increase environmental benefits. Advanced biogas-to-electricity technologies are being solicited for livestock operations, wastewater treatment facilities, landfill gas systems and food processing plants. Up to 10 targeted projects will be awarded under the biogas solicitation.

California has tremendous renewable resources and biomass is one of the most significant of these resources. Solid-fueled biomass power plants, landfill gas-to-electricity projects and wastewater biogas-to-energy facilities provide over 1,000 megawatts of generating capacity to the state. However, California uses less than one-tenth of its biomass resources to meet electricity needs. Technology advances are showing that cofiring of natural gas in biomass boilers can help improve boiler efficiency while increasing the power plant's ability to provide needed peak capacity. Similarly, improvements in landfill gas-to-electricity processes are significantly increasing its affordability as an electricity source. Biorefineries and other integrated biomass conversion concepts could help meet the increasing demand for fuel oxygenates, as well as providing electricity and process energy. Modular biomass systems operating as distributed power systems could help provide local electricity demands, including those during peak hours.

Developing and deploying biomass energy systems capable of achieving these gains will require close cooperation and coordination among biomass industries, government agencies, environmental groups, electricity distributors and suppliers, and those organizations conducting research, education, training, and outreach. A California Biomass Energy Consortium was created to help provide this coordination. The consortium will generate:

- California Biomass Performance Reporting System
- Updated California Biomass Resource Assessment
- Web-based Biomass Technology and Economic Evaluation Tool
- Assessment of Advanced Biomass Energy Technologies
- White papers focusing on ways for biomass energy systems to meet California's electricity needs

Dairy Power Production Program:

In response to the electricity crises encountered during 2000 and 2001, the Legislature and Governor enacted SB5X to help resolve peak demand problems in California. \$10 million of SB5X funds were allocated to help "encourage the development of manure to methane power production on California dairies." PIER Renewables was actively developing research work on biogas systems for use on livestock operations, and consequently was assigned responsibility for developing and implementing the resulting Dairy Power Production Program.

During the reporting period, the program structure was established, a program administrator and advisory group developed, an extensive marketing was conducted and applications from dairies across the state were received and evaluated. To date, approximately \$2.9 million in grants have been approved to install commercial biogas-to-electricity at eleven California dairies. The projects will help demonstrate that biogas-to-electricity systems are commercially available, provide California dairies with the ability to address air and water quality concerns associated with the wastes from over 18,000 dairy cows, and help provide up to 13 million kilowatt-hours per year of electricity needed by California dairies.

B. Environmentally-Preferred Advanced Generation (EPAG)

The deployment of EPAG technologies will provide greater flexibility and control in the delivery of electricity, heat and shaft power to industrial, commercial and residential operations. Current predictions are that as much as 20 percent of new electricity generation capacity through the year 2020 will be in the form of distributed, on-site generation.

1. Competitive Solicitation for Fuel Cells, Micro/Small Turbines, and Hybrids

In April 2001, the EPAG team released a solicitation for proposals for RD&D focused on fuel cells, micro and small turbines (<20 MW), fuel cell or turbine hybrid systems, and related technologies.

As of April 2002, the following nine projects were approved for PIER awards totaling \$22,850,000.

- **Alzeta Corporation** (under contract during the reporting period)

Alzeta was awarded \$2,404,310 for a project titled *Ultra-Low NOx Combustor for a 13.5 MW Turbine Generator*. Total project cost is \$3,480,820, with the company providing \$1,076,510 in match funding. The project will continue development of an end-use, ultra-low emission combustor that can be retrofitted on a 13.5 MW Solar Turbine gas turbine. The technology avoids the high cost of exhaust gas cleanup, and will be adaptable to other sizes of

turbines and other manufacturers. Natural gas-fired combustion turbines are widely used for generating electricity.

- **Clean Energy Systems Inc.** (The Commission approved this contract and contractor received contract during the reporting period)

Clean Energy Systems Inc. was awarded \$2,003,286 for a project titled *A 500kW Zero-Emission Gas-Fired Power Plant*. Total project cost is \$4,049,217, with the company providing \$2,045,931 in match funding. The project will demonstrate the long-term reliability of a unique, zero emissions, 500 kW gas generator as it drives a steam turbine to generate electricity at a commercial power plant in Contra Costa County. Exhaust carbon dioxide will be captured for industrial use.

- **Lawrence Livermore National Laboratory** (The Commission approved this contract and contractor received contract during the reporting period)

Lawrence Livermore National Laboratory was awarded \$3,000,000 for a project titled *Reduced Temperature Solid Oxide Fuel Cells with Direct Oxidation of Natural Gas*. Total project cost is \$9,000,000, with the laboratory providing \$6,000,000 in match funding. The project will develop a commercially viable Solid Oxide Fuel Cell (SOFC) with high reliability, reduced operating temperature, high power density, low degradation rate, high efficiency, and negligible emissions. A startup company with strong financial backing has obtained licenses from LLNL and is planning to commercialize the fuel cell for electricity generation.

- **Gas Technology Institute** (The Commission approved this contract and contractor received contract during the reporting period)

Gas Technology Institute was awarded \$2,999,998 for a project titled *Power Module for Multi-Fueled, 10-100 kW Solid Oxide Fuel Cells*. Total project cost is \$4,309,202, with GTI providing \$1,309,204 in match funding. The project will design, construct and operate a unique, low-temperature, 1-3kW module for a 10-100kW SOFC to produce electricity with negligible emissions. The focus will be on radiative and convective heat transfer, thermal and load cycling performance, reliability, and high efficiency.

- **ALM Turbine Inc.** (The Commission approved this contract and contractor received contract during the reporting period)

ALM Turbine Inc. was awarded \$2,867,270 for a project titled *Testing, Optimization and Demonstration of an EPAG Microturbine*. Total project cost is \$6,272,713, with the company providing \$3,405,443 in match funding. The project will use several novel technologies - predominantly developed by Russian engineers now living in the U.S. - to develop a 300kW gas turbine

that has high efficiency over a broad power range, low emissions, and low cost. Most gas turbines have high efficiency only at full power.

- **GE Energy & Environmental Research** (The Commission approved this contract and contractor received contract during the reporting period)

GE Energy and Environmental Research was awarded \$1,959,013 for a project titled *Integrated DG with PEM Fuel Cell and Autothermal Cyclic Reformer*. Total project cost is \$4,000,000, with the company providing \$2,040,987 in match funding. The project will continue development of a novel, fuel-flexible, low-cost, efficient, low-emission reformer for generation of hydrogen, that can readily be integrated with a 50kW proton exchange membrane (PEM) fuel cell. Current small-scale reformers are expensive, inefficient, and emit pollutants such as NO_x.

- **Catalytica Energy Systems** (This contract was approved at a Commission Business Meeting shortly after the end of this reporting period)

Catalytica Energy Systems was awarded \$2,997,988 for a project titled *Xonon Ultra-low NO_x Combustion in Small Multican Turbines*. Total project cost is \$6,392,292, with the company providing \$3,394,304 in match funding. The project will develop and demonstrate multi-can catalytic combustion on a gas turbine for ultra-low emissions. The technology has been demonstrated on the single-can combustors of small turbines, but control systems need to be developed for larger multi-can turbines. The results will be adaptable to different turbine manufacturers.

- **Gas Technology Institute** (This contract is drafted but has not been approved by Commission at this time)

Gas Technology Institute was awarded \$1,618,084 for a project titled *Partial Oxidation Gas Turbine for Electricity and H₂ Production*. Total project cost is \$3,236,167, with the company providing \$1,618,083 in match funding. The project will develop and demonstrate a gas turbine with the combustor replaced by a unique partial oxidation reactor. The turbine exhaust can be used as fuel for fuel cells, furnaces, or boilers, resulting in high-efficiency, low-emissions hybrids or combined heat and power systems.

- **Solar Turbines Inc.** (This contract drafted but has not been approved by Commission at this time)

Solar Turbines Inc. was awarded \$2,999,644 for a project titled *Catalytic Combustor-Fired Industrial Gas Turbine*. Total project cost is \$4,622,649, with the company providing \$1,623,005 in match funding. The project will implement cost-effective, low-emission, catalytic combustion in a 5.3MW gas turbine (with applicability to a 4.6 MW turbine). Catalytic combustion avoids

costly post-combustion (exhaust gas) cleanup. This project extends a current PIER effort involving Solar Turbines and Catalytica and will speed introduction of the technology into the California market.

C. Buildings End-Use Energy Efficiency

During this period, the PIER Buildings Energy Efficiency Program:

- Received notification of a successful award on one of two proposals submitted by PIER to the federal Department of Energy (DOE) for multi-state collaborative research. A contract to initiate this *Capturing the Daylight Dividend* collaboration will be developed later this year.
- Awarded a contract to develop cool colored roofing materials. This research will develop blends of different 'cool' materials to produce the colors desired by homeowners. Testing to quantify how cool roofing materials perform over extended periods of time in the field will be conducted to validate performance. Manufacturing partners will be particularly critical to ensure that specific market products are produced. The successful outcome of this research could lead to widespread adoption of cool colored roofing materials, which will lower the demand for cooling during the hot season, extend the life of roofing materials, and reduce the rate of smog formation by lowering ambient air temperatures.
- Awarded a contract to develop advanced windows. Electrochromic glazings offer dynamic and responsive control of the thermal and optical properties of the building facade. However, there are significant questions of technical, engineering, architectural, and general public interest that remain to be answered. This contract is a collaborative effort supported by the Commission, the Department of Energy, and the Environmental Protection Agency to develop, demonstrate, and evaluate integrated electrochromic window systems that will yield benefits of national interest (energy efficiency, peak demand reductions, and comfort). In addition it will demonstrate, validate, and quantify the technical performance of these systems in buildings, and develop the information products needed to support effective use of this technology in buildings with minimal risk and performance uncertainties.
- Initiated a multi-state collaborative effort through the Association of State Energy Research and Technology Transfer Institutions (ASERTTI) to develop an energy research plan in the area of indoor air quality (IAQ). The objective of this effort is to identify the highest priority research needs pertaining to the relationship of indoor environmental quality, health, occupant satisfaction, and worker performance with building energy use, including with the building systems and practices affecting energy use. The end product of this effort will be a research plan in the area of indoor

air quality. The research plan will include both short (1-5 years) and mid-term (6-10 years) research needs. Developing this plan in collaboration with other ASERTTI members creates the opportunity to bring together core expertise from around the country during the planning process and to proceed with implementing IAQ research in the U.S. in a programmatic, coordinated manner.

- Progressed on development of a comprehensive lighting research portfolio bringing together expert researchers in partnership with the lighting industry to develop products and lighting solutions that will have short-term impacts in energy and demand savings in California. This lighting research program will be initiated later this year and will specifically address advanced lighting technologies; enhanced controls and demand responsive systems; advanced lighting fixtures; lighting metrics; lighting design; and lighting standards and codes. Market connections with industry partners are a key element of this program and will ensure market relevance of the research performed in this program.
- Extended a duct sealing research activity to test the performance and durability of specific products for sealing ducts to increase energy efficiency of thermal distribution systems in California. The goal of this work is to provide information that can be used to improve the success of duct sealing efforts in California buildings. Objective and sound test methods are needed for duct sealing longevity to ensure that duct sealing promotions currently underway in California achieve the energy savings and other consumer benefits possible from this energy efficiency measure. Published results on newly developed duct sealing products will provide helpful information to heating ventilation and air conditioning (HVAC) contractors, duct sealing practitioners, and the general public. The Energy Commission staff will use duct sealant longevity testing results in their implementation and further development of the Building Energy Efficiency Standards.

D. Industrial/Agricultural/Water Energy Efficiency

During this reporting period, the PIER Program's Industrial, Agricultural and Water Efficiency team has undertaken the following activities:

- **Development of Load Characterization for Data Centers and an Energy Efficiency Improvement Roadmap**

A contract with the Lawrence Berkeley National Laboratory (LBNL) was approved to meet a growing need to improve the energy efficiency of the facilities that house computers and network equipment. Such facilities, commonly called data centers, are the heart of an electronics-based e-commerce infrastructure. These energy-intensive facilities require a high degree of electric power reliability. The PIER-funded project will benchmark

and categorize a representative sample of data center facilities and develop a roadmap to define the research opportunities for more energy efficient data centers. The project objective is to achieve a minimum of 30 percent reduction in energy use by data centers compared to current design practices.

- **Development of Compressed Air System Energy Efficiency Baseline Standards**

In March 2002, the Commission approved a PIER-funded contract with Southern California Edison (SCE) to develop a baseline standard for measuring the energy efficiency of compressed air systems. Almost all industries in California use compressed air for their manufacturing operations. In some industries, however, 40 percent of the energy associated with the use of compressed air systems is wasted. At present there are no methods available to quantify the efficiency of the compressor central plant system. In collaboration with the California utilities and the Energy Efficiency Coordination Council, the IAW program has funded a project that will develop the methodology needed to quantify the system efficiency for central plant air compressor systems. The project will also establish procedures for enhancing the efficiency of compressed air systems. Development of a baseline standard for measuring the efficiency of compressed air systems will allow utilities to develop a rebate program based on an accurate measurement of efficiency improvements.

- **Demonstration of an Energy Efficient Industrial Refrigeration and Heating Technology**

The Commission approved a contract with Energy Concepts Company (ECC) to supply, install and monitor the performance of two 30-ton gas-fired heat pump (GHP) units to meet the base refrigeration and hot water needs at a poultry processing plant and a small brewery. The use of this new technology could potentially reduce the electricity used for process cooling by 80 percent and increase the Coefficient of Performance (COP) for water heating up to 1.5 in the food processing industry. Many food and beverage industries require both heating and cooling for process and storage applications. Electrically-driven refrigeration systems are most commonly used to provide cooling while gas-fired boilers or water heaters are used to supply heating. Consequently, the cost and reliability of the electricity for cooling and refrigeration is a major concern of the industry. Demonstration of this new technology will reassure potential users in the target industries who are generally skeptical of claims of new technologies. This pilot demonstration will also help convince the manufacturers of industrial cooling and heating equipment to consider mass production once performance claims have been verified and accepted.

- **Collaboration for Water & Wastewater Treatment Efficiency Research with the American Water Works Association Research Foundation (AWWA-RF)**

The PIER program staff has developed a proposed contract with the American Water Works Association Research Foundation (AWWA-RF) to develop a technology roadmap for water and wastewater treatment technologies and to fund high priority research projects. The PIER program and AWWARF would each contribute funds towards the development of a RD&D plan and for research projects. Water treatment is very energy intensive and the water industry is interested in cutting its electricity costs, as increased environmental and health concerns require new technologies that primarily rely on electricity for pumping and treatment. The collaborative program with the AWWARF will explore opportunities for new technologies or processes to mitigate the anticipated increased cost of electricity used in California water and wastewater operations, as well as address industry concerns with the reliability of electricity supplies.

- **Analysis of Power Quality Impact**

The PIER program, in collaboration with the Electric Power Research Institute (EPRI), completed two analytical studies in the area of power quality. The first study, *Assessing the Impact of Power Quality on California Industries*, looks at the economic impacts on industry of power quality problems, including voltage sags, swells, interruptions, over-voltages, flicker, harmonics, notching, transients, and other phenomena.

The second study, *Guidebook on Power Quality Considerations for Energy Saving Products*, developed guidelines for making informed decisions when selecting energy efficient products that may affect the users' power quality.

- **Collaborations with Industries and Organizations**

The Industry, Agriculture and Water (IAW) Efficiency program staff is continually engaged in discussions with various organizations to better understand energy issues and needs for the industrial, agricultural and water processing and treatment sectors. Working with stakeholders, the program staff develop RD&D research plans that are responsive to industry research needs. For example, the PIER program staff is actively working with the Silicon Valley Manufacturing Group and the California Food Processing Industry to develop RD&D roadmaps for future research. During late-2001 and early 2002, several workshops were held to help industry representatives identify specific energy issues. These issues were, in turn, used to identify the technology and scientific advancements necessary to overcome these problems. Using this process, the RD&D plans for the food processing market sector and the electronics/e-commerce market sector should be available by summer 2002.

E. Energy-Related Environmental Research

During the past six months, three PIER Program initiatives in the area of energy-related environmental research was completed. These projects are representative of research conducted under the Global Climate Change, Land Use and Habitat, and Water Impacts core focus areas.

The following are some highlights of these newly-completed research activities in the environmental research area:

- **Global Climate Change: California Greenhouse Gas Inventory**

California is characterized by a moderate climate, industries that emit relatively moderate levels of carbon dioxide, and active energy and air quality programs capable of indirectly reducing greenhouse gas emissions. California's emissions per capita and emissions per dollar of state product are low compared with other states.

The rate of emissions growth in California is relatively modest compared to increases elsewhere in the United States, largely the result of fuel switching to natural gas, relatively low hydropower production in 1990 that was compensated for by burning fossil fuels in power plants, the continuing effect of energy efficiency policies and standards, and an increase in electricity imports. Without these factors, gross emissions in 1999 would have been about eight percent higher in 1999 than in 1990. Even though California's rate of emissions growth has been modest, its total carbon dioxide emissions are very high, second only to Texas in the United States.

In the international arena, California emissions from fossil fuel combustion per dollar of gross state product are much lower than U.S. emissions from fossil fuel combustion per dollar of gross domestic product, but comparable with several western European countries.

- **Land Use and Habitat: Golden Eagles in a Perilous Landscape**

In the Altamont Pass Wind Resource Area (WRA), wind turbine blades kill an estimated 40 – 60 golden eagles per year and represent a significant mortality source. Due to their frequent occurrence in the WRA and to their tendency to hunt for live prey while in flight, subadults (ages 1-3) and nonbreeding adults are more vulnerable to turbine strikes. Circumstantial evidence suggests that areas containing Kenetech 56-100 turbines on an 18.3-meter lattice tower present the greatest hazard. The turbines are rated between 40 and 750 kWh. However, it is not clear if the turbines themselves or extraneous environmental factors associated with the location are causing the fatalities.

The regional eagle population does not appear to be declining and nesting territories in the vicinity of the WRA have remained occupied. However, concern remains for the high mortality rate of eagles from turbines, particularly because they are the future breeding population and because impacts from land use changes in the vicinity of the WRA is resulting in a high degree of emigration.

- **Water Impacts: Comparative Analysis of Dry Cooling**

Power plant dry cooling technologies significantly reduce a power plant's water demand. On average, a 500-MW combined-cycle power plant using wet cooling technology requires 3 million gallons of water per day for cooling. The same power plant using dry cooling technology will require only about 5 percent—or 0.15 million gallons per day of this total. The water savings, approximately 2.85 million gallons from one power plant *for one day*, could satisfy the water demands of more than 12,445 people annually—nearly enough to supply the needs of Auburn, California *for an entire year*.

F. Energy Systems Integration Research

During this reporting period, the Energy System Integration Research program area team undertook the following RD&D projects:

- **The Consortium for Electric Reliability Technology Solutions (CERTS)**

The RD&D Committee approved the second year of funding for the CERTS project at \$2.4 million. CERTS includes the contractor Lawrence Berkeley National Laboratory (LBNL), Oak Ridge National Laboratory (ORNL), Edison International, Power Systems Engineering Research Consortium (PSERC) and Sandia National Laboratory (SNL), Electric Power Research Institute (EPRI), and California Independent System Operator (CAISO).

The purpose of this project is to address the transition of California's electricity supply and delivery infrastructures from vertically integrated, regulated and government-controlled organizations to desegregated, competitive, market-driven institutions. Power supply, network management and control systems are being driven to find new solutions to the traditional methods used to ensure stable power flows, frequency and voltage control. This project will provide integrated research and technology development that will help produce quicker and more flexible options for meeting the reliability, stability and ancillary service needs of California's electricity consumers.

Highlights of the second-year activities for the CERTS project include:

- Real Time System Monitoring and Control - Complete implementation work for CAISO dispatchers on real time phasor-based monitoring system, enhance and expand VAR management system, initiate research work for

improving operational nomograms using phasor measurement technology and develop a market simulation capability to be integrated into the operator training simulator.

- DER Integration - Support CEC planning and implementation of a Micro Grid demonstration, enhance DER customer adoption model and continue work for a standard power electronics interface.

- **Pacific Earthquake Engineering Research Center (PEER)**

On March 20, 2002, the Commission approved an 18-month, no-cost time extension to the PEER contract. This extension was granted to assure completion of the more than 60 subprojects and to compensate for the late start of the contract, primarily due to the complexity of PG&E's bankruptcy. The purpose of this research project is twofold:

- To develop technologies and protocols to mitigate the vulnerability of electric systems to damage directly and indirectly caused by earthquakes.
- To develop assessment techniques to evaluate damage to electric systems caused by earthquakes and to assess fiscal impacts due to the loss of electric service to the community.

This research consists of seven research categories that are composed of individual projects, each of which will be under the direction of a Principal Investigator (Researcher) from Pacific Earthquake Engineering Research Center (PEER). The seven research categories are:

- Earthquake Ground Motion
- Site Response
- Permanent Ground Deformation
- Seismic Performance of Electric Substation Equipment
- Electric System Building Vulnerability
- Electric System Seismic Risk
- Emergency Response

- **Alternative Competitive Market Structures for California**

On November 7, 2001, the Commission conducted a public workshop on recent research looking at alternative competitive market structures for California. Given California's recent experience with competitive electricity markets it appeared that the design and implementation of the market was inadequate from the perspective of ensuring reliability. In California, the principal market mechanism that was supposed to stimulate construction of new generation was the Power Exchange's hourly market clearing price for energy. For generators who depended solely on the PX's energy market for revenue, profitability was largely a function of high prices paid during the

summer. As a result of this market structure, generators had a strong incentive to allow operating reserves to drop below the level needed to ensure reliable service. Generators can accomplish this by either not building new generation or withholding existing generation from the market. This kind of behavior on the part of generators contributed to the volatile electricity prices in California during the summer of 2000 and winter of 2000-2001.

Looking at price volatility and reliability from the demand-side of the market, the insulation of customers from high electricity prices through a legislated rate freeze, muted any incentive to reduce loads. The failure to incorporate demand responsive load programs into the design of the market also contributed to price volatility and poor reliability.

This workshop evaluated alternative market structures from two perspectives: first, the ability of alternative market structures to incent the timely addition of new generation so as to reduce price volatility and contribute to reliable service, and second, the ability of various market structures to facilitate robust demand-side participation in the market through programs or mechanisms that allow consumers to respond to real time prices.

Andy Ford of Washington State University and Stephen Lee of EPRI presented the results of their analyses using models that look at alternative market structures and generation investment patterns.

During this reporting period, the Energy System Integration Research program area also obtained results from the following RD&D projects:

- **Strategic Distributed Energy Resources Research Assessment Final Report**

The Energy Systems Integration (ESI) program funded Arthur D. Little, Inc. to assess research needs that focused on integrating distributed energy resources into the distribution system. Significant developments in Distributed Energy Resources (DER) technology and the marketplace require a fresh analysis of the DER landscape to identify key challenges appropriate for public interest research. The ESI program area is developing its five-year research plan in the following DER focus areas:

- Interconnection
- Grid effects
- Market integration

This report documents a major step in the research plan development process to understand current research being conducted by industry, nonprofit organizations, and government and to identify where gaps exist.

From these efforts, the PIER-ESI program will develop a solicitation to address those activities.

Information was collected through research, interviews, and a public workshop to identify research gaps and prioritize public funding. A literature search of multiple sources was first conducted to determine past, present and planned research projects in the private and public sectors. Significant additional input was obtained through interviews with representatives of industry, nonprofit and government efforts in DER, and a public workshop held with stakeholders.

Key issues and R&D strategies to address the three areas of interconnection, grid effects and market integration were identified and organized from the acquired information. A framework was created for assessing the status of the DER research efforts. Issues are the critical questions facing the development of DER in the areas of interest. These issues have driven, or will drive, the creation of strategies to address these questions. Strategic thrusts are a group of aligned strategies within a focus area. Current and potential projects, in each of the three areas, are employing these strategies. There are also crosscutting projects that are addressing issues in more than one area. Each project/activity identified can be mapped to the appropriate strategy and issue. The *Strategic Distributed Energy Resources Research Assessment Final Report* can be found on the Commission's Web page under Publications (P600-01-016F).

- **Distributed Energy Resources Public Web**

The Energy Systems Integration program funded a tailored collaboration project with EPRI to provide current, reliable, and actionable information to assist policy makers, consumers, researchers, academic community and other interested parties in evaluating and implementing distributed energy resources. The Commission contributed \$160,157 of the total \$320,314 project cost. The information is presented in a way that addresses the needs of consumers in California who may be interested in distributed energy resources in their home or business. It provides salient information needed by policy makers regarding the opportunities, impacts and market potential for distributed energy resources. Lastly, for the research community, it is a central repository of recent technology developments. The *Distributed Energy Resources Public Web* went live on the Commission web page in January 2002.

- **DER Interconnection Standards Outreach**

Energy Systems Integration Program staff initiated two outreach efforts on the revised Rule 21 interconnection requirements to municipal utilities, cooperatives and irrigation districts. This outreach effort was through the FOCUS II contract. The first meeting took place in Riverside on November

2001. The second meeting was on April 10, 2002 in Roseville. The meeting targeted Northern California members of the California Municipal Utilities Association to enlist their participation in using revised Rule 21 for interconnecting distributed generation units to their systems. The goal is to have all electricity providers statewide using the common interconnection requirements, applications and contracts in an effort to reduce costs and time for customers seeking to connect to the grid.

III. PIER COLLABORATIVE RESEARCH FUNDING STATUS

PIER funding of collaborative efforts headed by other energy research organizations allows the Energy Commission to participate in many statewide and national RD&D activities, thus allowing California to provide input and receive benefits from these broadly funded RD&D efforts. During the current reporting period, the Energy Commission reached an agreement with the Electricity Innovation Institute (E2I) to perform collaborative research, development and demonstration projects in the amount of \$1,076,325. Last year, E2I joined the Electric Power Research Institute (EPRI) family of companies as a not-for-profit subsidiary, with the specific intent of working more closely with the public sector and meeting the public sector's need for public access to the research results. EPRI has agreed to provide the match funds to E2I for purposes of supporting this joint research program. This collaborative research program benefits the state by obtaining additional research from funds already expended and by obtaining for the public greater access to the research results. Projects are being defined and will be implemented in each of the PIER program areas.

IV. ENERGY INNOVATIONS SMALL GRANT FUNDING STATUS

- **Small Grant Awards**

Through the PIER-funded Energy Innovations Small Grant Program, the Energy Commission has released nine solicitations to date. For the first seven solicitations, the Energy Commission has approved 81 projects totaling over \$5.9 million. During the current reporting period additional grant proposals from a solicitation conducted in October 2001 were received, reviewed and evaluated by the PIER staff. The successful proposals are now awaiting final Energy Commission review and approval. A complete status of the PIER Small Grants Program is summarized in the table on the following page.

Energy Innovations Small Grant Program Funding Summary					
Solicitation	Release Date	Due Date	Business Meeting Date	Grants Awarded	Funded
99-01	3/31/99	4/30/99	8/11/99	13	\$973,966
99-02	4/30/99	5/31/99	11/17/99	5	\$374,595
99-03	8/30/99	9/30/99	1/26/00	11	\$824,530
99-04	12/17/99	1/28/00	7/12/00	10	\$741,769
00-01	3/15/00	4/28/00	9/20/00	7	\$524,751
00-02	6/15/00	7/28/00	12/20/00	11	\$818,194
00-03	8/31/00	10/31/00	3/21/01	4	\$297,315
00-04	12/30/00	1/31/01	6/27/01	11	\$812,446
01-01	3/2/01	4/30/01	10/31/01	9	\$674,531
01-02	10/5/01	11/16/01		Pending	

- **Small Grant “Follow-on” Funding**

To date, two small grant projects which successfully established early concept feasibility have gone on to seek and receive follow-on PIER funding of more than \$4.4 million.

- **Small Grant Research Reports**

The following grant project final reports were published during the past six months:

- Grant number 99-39, “High Efficiency, Single Phase Air Conditioner”, Dr. Otto J. M. Smith
- Grant number 99-20, “Development of a Unique Gas Generator for a Non-polluting Power Plant”, Roger E. Anderson
- Grant number 99-13, “Improved Operational Turndown of an Ultra-low Emission Gas Turbine Combustor”, John D. Sullivan
- Grant number 99-06, “Renewable Hydrogen Fuel Production by Microalgal Photosynthesis”, Anastasios Melis
- Grant number 99-03, “Control of On-Off Equipment in Buildings”, David M. Auslander

V. OTHER PIER PROGRAM ACTIVITIES

• Technology and Information Transfer/Reporting Activities

Technology and information transfer is critical to the success of any RD&D effort. Accordingly, during the past reporting period the PIER Program has performed the following activities:

The PIER staff completed its *Fourth Annual PIER Report to the Legislature* March 31, 2002. The report provides detailed information on all PIER activities that occurred during the 2001 calendar year, as required by law.

In March, the Commission contracted with the Environmental Business Cluster (EBC), a member of the National Alliance of Clean Energy Business Incubators, to provide business consulting services to Public Interest Energy Research Program contractors. Under the pilot program, EBC will provide business consulting services and membership in the incubator to ten companies over a period of one year. Seven companies have been selected from those that applied for business consulting services. The Cluster's Director has coordinated with company managers to define specific scopes of work for business consulting services from EBC staff and expert consultants, including such activities as business plan and market strategy development, financing assistance and staff development. Applications from PIER contractors have been requested for the remaining places in this ten-company pilot.

PIER is planning to participate in the upcoming Industry Growth Forum (IGF) with the National Renewable Energy Laboratory (NREL) scheduled in Albany, NY in October 2002. Venture capitalists and "angel investors" from throughout the country serve as panelists for the IGF, through which we hope to feature PIER-funded research projects.

During this reporting period, the Energy Commission also continued collaborative efforts with Science Applications International Corporation (SAIC) to redesign the PIER website. The PIER staff provided program information to SAIC for input into the new Web Site. The new PIER website "went live" in December 2001.

The Technology Transfer Program is producing three additional "PIER Success Story" fact sheets. This brings to nine the number of PIER projects showcased in the success stories, which include:

- Catalytica low NOx catalytic combustion (new)
- Real-Time ratings of transmission lines (new)
- Spray-enhanced dry cooling of power plants (new)
- PowerLight Photovoltaic (PV) manufacturer

- Kalina cycle low-cost power generator
- Alzeta low NOx turbine
- Berkeley energy efficient lamp
- Distributed generation interconnection streamlining
- Energy efficient fume hood technology

The PIER Program and staff recently co-sponsored and participated in a number of technology transfer events and activities:

- Co-sponsored, hosted and spoke at the one-day workshop *“ENERGY SOLUTIONS FOR CALIFORNIA INDUSTRY: Ways to Improve Operations and Profitability”* January, 2002 in San Jose
- Co-sponsored with DOE the *14th NREL Industry Growth Forum* in San Jose November 6-7, 2001; PIER projects presented business plans to venture capital firms and angel investors
- Spoke at *Energy Efficiency Lighting Systems* meeting February 21-22, 2002 in Tucson, Arizona
- Participated in the *Air Conditioning and Refrigeration Institute Steering Committee Meeting* November 7, 2001 in Washington, D.C.
- Participated in the *ASHRAE Winter Meeting* January 12-16, 2002 in Atlantic City, NJ
- Participated in the *ACEEE National Symposium on Market Transformation* March 25-26, 2002 in Washington, DC
- Participated in the *Center for the Built Environment Semi-Annual Partners Meeting* April 18, 2002 in Berkeley
- Co-sponsored and spoke at the *Commercial Diagnostics Meeting* April 16-17, 2002 in Oakland
- Co-sponsored and spoke at the *Framing Factors Public Workshop* November 14, 2002 in Sacramento
- Co-sponsored and spoke at the *Program Advisory Committee Meeting on Profitability, Quality and Risk Reduction Through Energy Efficiency* March 21, 2002 in Sacramento
- Co-sponsored and spoke at the *Program Advisory Committee Meeting on Productivity and Building Science* January 30, 2002 in Sacramento

- Co-sponsored and spoke at the *Program Advisory Committee Meeting on Energy Efficient and Affordable Small Commercial Buildings* January 29, 2002 in Sacramento
- Co-sponsored and spoke at the *Program Advisory Committee Meeting on Low Income Housing* November 20, 2002 in Sacramento
- Presented a summary of the EPAG reciprocating engine activities at the *DOE Reciprocating Engine PEER Review Meeting* April 23-24, 2002 in Chicago, IL
- Presented a summary of PIER activities related to hybrid technology development at the *DOE Hybrid PEER Meeting* April 14-17, 2002 in Charlotte, NC
- Presented a summary of PIER Program activities related to distributed generation (DG) to the *EPRI DG Target Meetings* March 18-19, 2002 in Dallas, TX
- Presented a summary of PIER activities and the development of DOE's Advanced Generation Program at *DOE's Advanced Generation Program Planning Meeting* March 12-13, 2002 in Fairfax, VA
- Presented a summary of the PIER Program and participated as a reviewer at the *DOE Distributed Energy Resources PEER Program Review* meeting November 28-29, 2002 in Washington, DC
- Participated in an Industrial Review Team meeting at the *National Fuel Cell Research Center* November 14-15, 2001 in Irvine
- Co-sponsored and spoke at the *CADER* conference November 1-2, 2001 in San Diego
- Co-sponsored and spoke at the *ICEPAG Colloquium* February 5-6, 2002 in Costa Mesa
- Presented a paper at the *PV Alliance* meeting December 14, 2001 in Sacramento
- Presented a paper and co-chaired with the U.S. Environmental Protection Agency the *International Emission Inventory Conference* April 15-18, 2002 in Atlanta, GA.
- Chaired a session "Energy and the Environment" at the *Western Section of The Wildlife Society annual conference* March 7-9, 2002 in Visalia, CA.

- Conducted a workshop “*Demand Response Roundtable*” November 16, 2001 in Sacramento, CA
- Participated in the EPRI/Energy Innovations Institute’s (E2I) *Distributed Resources Partnership* meetings December 10-11, 2001 and January 21-25, 2002 in Washington, D.C.
- Spoke at the *Wireless Sensor Workshop* January 2002 In Berkeley, CA
- Co-sponsored and spoke at the *Seventh Annual Power Conference on Electricity Industry Restructuring* March 22, 2002 in Berkeley, CA

In the near future, PIER is co-sponsoring the final in a series of three workshops “ENERGY SOLUTIONS FOR CALIFORNIA INDUSTRY: Ways to Improve Operations and Profitability” in Buena Park, California, May 15, 2002.

- **PIER Program Evaluation Efforts**

The PIER Program is engaged in continuous efforts to evaluate the success of its RD&D projects, the public benefits derived from the program as a whole, as well as the administrative efficiency of the program. This evaluation effort has continued throughout the past reporting period, and is reflected, in part, in the ***PIER 2001 Annual Report*** which was finalized and filed with the Legislature on March 31, 2002.

VI. CONCLUSION

The Energy Commission remains fully committed to administering the PIER Program in an efficient and effective manner that ensures public input and accountability. The PIER section of the Energy Commission’s website is a means of communicating with stakeholders and the public. The website and all reports can be accessed at:

www.energy.ca.gov/research/PIER/index.html